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Case Report

# Systemic air embolism in a fungal pneumonia patient with lung cavities formation and review of literature

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ABSTRACT

Systemic air embolism is a rare but potentially fatal complication related to many factors. The purpose of this article is to alert clinicians once patients occurs an abnormal neurological and cardiovascular status, following minor traumatic treatment, air embolism should be considered. A 20-year-old man who presented with fungal pneumonia with lung cavities formation was admitted to an intensive care unit (ICU) and received positive airway pressure ventilation. Four days later, the fungal pneumonia was improved, but the patient's blood pressure and arterial oxygen saturation deteriorated, so computed tomography (CT) scans were preformed to reevaluate him. The scans detected air embolism in the left atrium and ventricle, ascending aorta, aortic arch and its branches (right brachiocephalic, bilateral common carotid and right subclavian arteries), descending aorta and right coronary artery. A CT scan of the abdomen revealed air in the spleen, cauda pancreatic, superior mesenteric artery and right external iliac artery. The patient died two days later from multiple organ dysfunction. We suggest that vascular air embolism should be considered under mechanical ventilation when patients' neurologic and cardiovascular status deteriorates, and hyperbaric oxygen therapy should be conducted immediately.


## Introduction

Air embolism in the vessels is an iatrogenic complication may result in poor outcomes, which caused by invasive medical procedures performed in intensive care and emergency units. It occurs in either arteries or veins when air gets into arterial or venous system during the invasive medical procedures of arterial catheterization or cardiopulmonary bypass, and it has been focused gradually.[1,2] Arterial air embolism is an uncommon but life-threatening complication, especially when it related to pulmonary barotrauma.[3,4] Karegowda et al.[5] reported air embolism appears in the arteries of local organ. However, in this report ventilation-induced embolism was systemic, which air emboli occurs in systemic organ arteries. This case report presented a lethal air embolism associated with positive pressure ventilation in a patient with lung cavities due to fungal pneumonia.

## Case report

A 20-year-old man presented to the emergency department because of one-week history of cough, expectoration, fever and exacerbated dyspnea. He had a medical history of laparoscopic appendectomy and acute drug-induced liver disease in the previous month, and was treated with 20 mg methylprednisolone every day for about one month.

Physical examinations showed that his respiratory rate was 25 breaths/min, heart rate was 120 beats/min and blood pressure was 92/58 mmHg. His transcutaneous peripheral blood oxygen saturation was 92%, axillary temperature was 38.6°C. Chest auscultation revealed bilateral crackles. The remainder of the physical examination was unremarkable.

The complete blood count revealed slight anemia with hemoglobin of 92 g/L, a white blood cell count of $7 \times 10^9$/L with 89.2% neutrophils. The patient had an elevated C-reactive protein level of 235 mg/L. A blood chemistry test showed an elevation of glutamyl transpeptidase (333 U/L), alkaline phosphatase (421 U/L), total bilirubin (65 μmol/L) and direct bilirubin (58.9 μmol/L), and a decrease of albumin (22.7 g/L). Serum electrolytes and creatinine

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were normal. The patient had an elevated procalcitonin (PCT) level of 3.12 ng/mL (normal values are < 0.5 ng/mL) and a β (1, 3) D-glucan level of 2881.6 pg/mL (normal values are < 151.5 pg/mL). He also had negative T-SPOT.TB, sputum and blood culture results. Arterial blood gas values, without administration of supplemental oxygen, showed a pH of 7.4, PCO2 of 31.4 mmHg, HCO3 at 28 mmol/L and PaO2 of 70 mmHg, with a corresponding arterial oxygen saturation of 92%.

In the emergency department, a computed tomography (CT) scan of the chest was performed and it showed many thick-walled cavities with consolidation and ground-glass infiltrate (Fig. 1). Immediately after the CT scan, the patient became breathless and arterial oxygen saturation started falling. The patient was intubated and ventilated with the help of a mechanical ventilation (pressure controlled ventilation including inspiratory pressure of 24 cm $H_2O$, tidal volume of 520 mL, breathing frequency of 12 breaths/min and positive end expiratory pressure (PEEP) of 5 cm $H_2O$). The patient was then transferred to the intensive care unit (ICU) for further therapy.

In the ICU, a central venous catheter was inserted into the left internal jugular vein, we found Aspergillus in his bronchoalveolar lavage fluid and a voriconazole injection was performed as the patient had presented with fungal pneumonia. Four days later, the patient's C-reactive protein level dropped to 60 mg/L and his PCT level was 0.66 ng/mL. However, his blood pressure and arterial oxygen saturation deteriorated, so another CT scan was performed to re-evaluate him. From the chest CT scan, air embolism was detected in the left atrium and ventricle, ascending aorta, aortic arch and its branches (right brachiocephalic, bilateral common carotid and right subclavian arteries), descending aorta and right coronary artery. The lung cavern wall had also became thinner (Fig. 2). A CT scan of the abdomen revealed air embolism in the spleen, cauda pancreatic, superior mesenteric artery and right external iliac artery (Fig. 3). The patient died two days later from multi-organ dysfunction.

## Discussion

As an iatrogenic event, air embolism often originates in veins due to decompression sickness or surgical procedures. Systemic air embolism is rare but can cause lethal heart or neural ischemia. Mortality rates for systemic air embolism are very high, ranging from 48% to 80% in adults.[6]

Systemic arterial air embolism is uncommon but potential fatal, which resulted from air into pulmonary vessels or systemic arteries. The rising pressure gradient between the airway and pulmonary vein may be the main cause of it, which might promote air into the pulmonary vein.[7,8]

PEEP ventilation, coughing during lung biopsy (valsalva manoeuvre), or chronic obstructive pulmonary disease with air trapping may increase the risk of air embolism. Lung diseases with cavity or cystic lesions also may increase risk of air embolism. Despite the application of protective ventilation,[9] barotrauma following mechanical ventilation (MV)[10,11] might be another potential factor to lead air embolism. Despite the effect of high tidal volumes, barotrauma was easy to caused when the peak inspiratory pressure reach 40 cm $H_2O$. However, some authors considered that PEEP might explain the detailed mechanism, especially when applied to an abnormal lung with low compliance, after a surgical procedures or a minor injury to chest along with MV.[12,13]

A central venous catheter was administered to this patient. Although air might have entered the vein, we found no patent interatrial shunt by the transthoracic echocardiography. There were no other acceptable causes for this arterial air embolism than MV over a structurally abnormal lung. Our hypothesis is that an increased bronchopulmonary pressure gradient due to positive pressure ventilation and heavy coughing, cause transmission of air from injured bronchus to pulmonary arteries and the systemic circulation—in case of a fistulae between the pulmonary veins and alveoli or bronchi. This is supported by the fact that this patient presented with fungal pneumonia, which caused tissue necrosis and lung cavities.

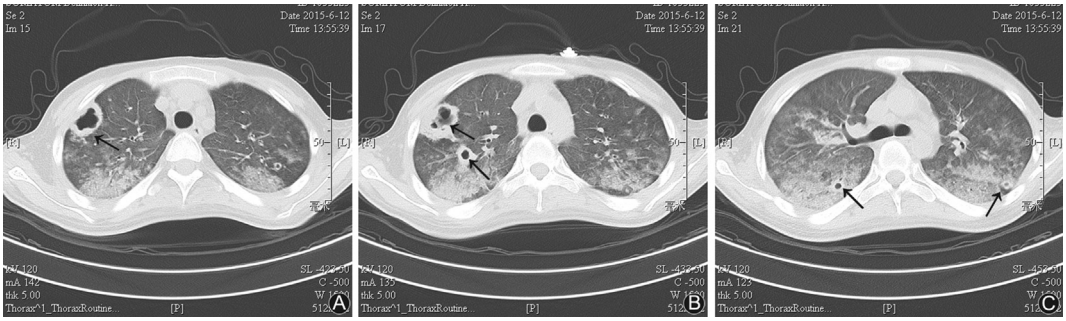


**Fig. 1.** Axial lung CT scan shows many thick-walled cavities with consolidation and ground-glass infiltrate.

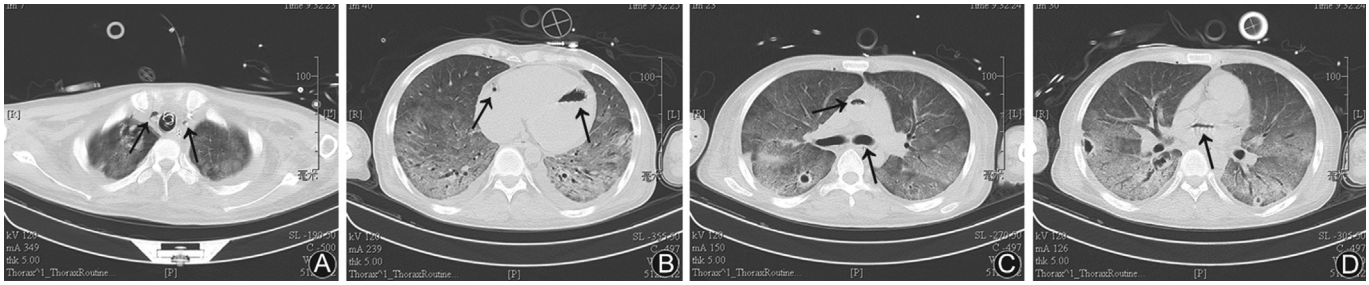


**Fig. 2.** Axial chest CT scan shows air embolism in bilateral right common carotid and subclavian arteries (A) right coronary artery, (B) aortic arch, (C) the left atrium and (D) the lung cavern wall became thinner.

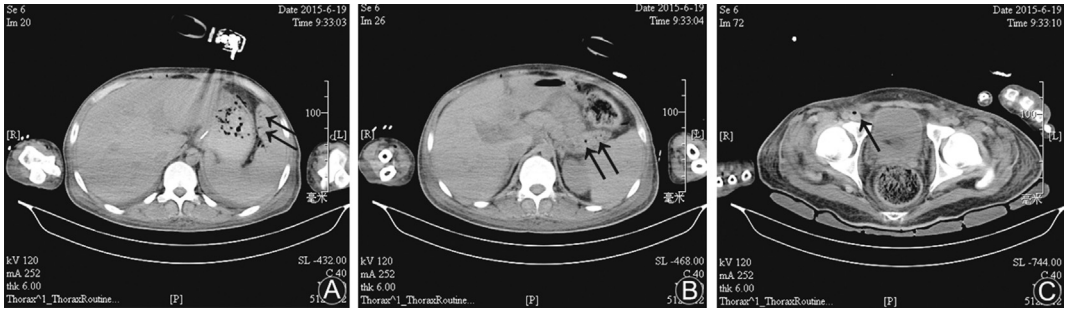


**Fig. 3.** Abdomen CT scan shows air in the spleen, cauda pancreatic (double arrow), superior mesenteric artery and right external iliac artery (arrow).

The clinical impression of a systemic air embolism is difficult to acquire. The result of clinical suspicion is followed deterioration in the patient's neurologic and cardiovascular status. Brain and chest CT scans might present a definitive diagnosis by showing air bubbles in the cerebral vessels, aorta, left atrium and the vessels with arterial blood flows in the chest.[14,15] In the present patient, although the fungal pneumonia might be improved, four days after admission his blood pressure and arterial oxygen saturation deteriorated. The systemic air embolism was an unintended consequence when we performed CT scans. Despite this, there is still insufficient evidence to confirm that systemic arterial gas embolism was caused by MV. Indeed, systemic arterial gas embolism is associated with other multiple reasons such as comprehensive result of MV, fungal infection and other rare factors.

The initial treatment consisted of immediately administering 100% oxygen and placing the patient in the left recumbent position while lowering his head as soon as once air embolism is suspected.[4] Hyperbaric oxygen therapy should be performed immediately is considered the treatment of choice for systemic arterial air embolism, as it decreases bubble volume and improves tissue oxygenation.[14] In the case, due to the deterioration of the patient's cardiovascular status, he did not receive hyperbaric oxygen therapy and died from multi-organ dysfunction two days later.

As soon as air embolism is suspected, the patient should immediately receive hyperbaric oxygen therapy including inhalation of 100% high-flow oxygen and placing in the right lateral decubitus position.[4,14–16] The deterministic treatment for arterial air embolism is hyperbaric oxygen therapy. The purpose of these measures is to increase tissue oxygenation.

In conclusion, we suggest that vascular air embolism should not be ignored under MV and minor trauma or surgical procedures. When a patient's neurologic and cardiovascular status has deteriorated, we should immediately implement hyperbaric oxygen therapy and perform a series of evaluation in order to exclude vascular air embolism.

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None.

## Ethical statement

This study was approved by the Ethics Committee of First Affiliated Hospital, Zhejiang University of Traditional Chinese Medicine.

## Conflicts of interest

The authors declare no conflicts of interest.

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